PB-217 426

HOLLEY RESERVOIR CALAPOOIA RIVER BASIN WATER QUALITY AND WATER SUPPLY REPORT

Federal Water Pollution Control Administration
Portland, Oregon

November 1969

DISTRIBUTED BY:

NTIS

National Technical Information Service
U. S. DEPARTMENT OF COMMERCE
5285 Port Royal Road, Springfield Va. 22151

FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
NORTHWEST REGIONAL OFFICE
PB 217 426

Library-1
PROPERTY OF
ENVIRONMENTAL PROTECTION A[illegible]
LIBRARY REGION X
1200 SIXTH AVENUE
SEATTLE, WASH. 98101

CALAPOOIA RIVER BASIN

HOLLEY RESERVOIR

WATER QUALITY and WATER SUPPLY REPORT

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
U S Department of Commerce
Springfield VA 22151

CLEAN WATER

NOVEMBER 1969

35

HOLLEY RESERVOIR
CALAPOOIA RIVER BASIN

WATER QUALITY AND
WATER SUPPLY REPORT

United States Department of the Interior
Federal Water Pollution Control Administration
Northwest Region
Portland, Oregon

November 1969

I

TABLE OF CONTENTS

	Page
INTRODUCTION	1
FINDINGS AND RECOMMENDATIONS	3
STUDY AREA DESCRIPTION	4
PROJECT DESCRIPTION	8
WATER RESOURCES	10
WATER USES	14
WATER QUALITY	18
BIBLIOGRAPHY	30

LIST OF TABLES

Table		Page
1	Population of Incorporated Places, Calapooia River Basin,	6
2	Present and Projected Population, Calapooia River Basin, Oregon, 1960, 1985, and 2010	7
3	Principle Features of Holley Dam and Reservoir	8
4	Recorded Stream Flow Data, Calapooia River Basin, Oregon	12
5	Mean Monthly Low Flows at Various Recurrence Frequencies, Calapooia River Basin, Oregon	13
6	Municipal and Industrial Water Demand, Calapooia River Basin, Oregon, 1960, 1985, and 2010	15
7	Projected Average Monthly Municipal and Industrial Water Demand at Brownsville, Calapooia River Basin, Oregon, 1985 and 2010	16
8	Surface Water Quality at Albany, Calapooia River Basin, Oregon	21

LIST OF FIGURES

Figure		Page
1	Calapooia River Basin	4
2	Schematic Diagram, Calapooia River	9
3	Calapooia River at Holley Reservoir, Natural Flows vs. Minimum Regulated Releases	11
4	Holley Reservoir - Regulated Release Flows	24
5	Predicted Holley Reservoir Isotherms - Calapooia River	25
6	Calapooia River Temperatures - Average Hydrologic Year	26
7	Calapooia River Temperatures - Minimum Hydrologic Year	27
8	July Temperature Profiles - Calapooia River	28
9	September Temperature Profiles - Calapooia River	29
10	October Temperature Profiles - Calapooia River	29

INTRODUCTION

Request and Authority

The District Engineer (U. S. Army Engineer District, Portland, Oregon) in a letter dated November 1, 1963, requested the advice of the U. S. Department of Health, Education and Welfare concerning the needs for storage for water supply and water quality control in the potential Holley Reservoir in the Calapooia River Basin, Linn County, Oregon.

The water supply portion of this study was made in accordance with the Memorandum of Agreement, dated November 4, 1958, between the Department of Army and the Department of Health, Education and Welfare relative to the Water Supply Act of 1958, as amended (43 U.S.C. 390b). The water quality control aspects are considered under authority of the Federal Water Pollution Control Act, as amended (33 U.S.C. 466 et seq.). Responsibility for these activities was transferred from the Department of Health, Education and Welfare to the Department of Interior by Reorganization Plan No. 2 of 1966, effective May 10, 1966.

Objectives

This investigation was conducted to advise the Corps of Engineers, relative to the proposed Holley Reservoir Project, on

1. The need for, and value of, storage for municipal and industrial water supply.

2. The potential water quality, both in the reservoir and the river downstream, resulting from the proposed project.

3. The need for, and value of, storage for water quality control.

Scope

To accomplish the stated objectives, available data on water uses, waste sources, and water quality were examined. Projections, supported by an economic base study, were made for conditions in 1985 and 2010. Water quality predictions, based on both typical and minimum hydrologic years, were made using mathematical models.

Acknowledgements

Information for this report was provided by officials of the communities of Brownsville and Halsey, the Oregon Department of Environmental Quality, the U. S. Soil Conservation Service, and the U. S. Army Corps of Engineers. The cooperation of these persons is gratefully acknowledged.

FINDINGS AND RECOMMENDATIONS

Findings

1. Water quality of the Calapooia River is predicted to meet Oregon State Standards both with and without the proposed project.

This finding presumes; (1) that the 22 cfs base flow set aside by the Oregon Water Resources Board will be maintained, and (2) that continued adequate collection, treatment, and disinfection of municipal and industrial wastes will be provided in the basin.

2. The proposed reservoir cannot consistently lower river temperatures to the levels considered necessary for the establishment and maintenance of an anadromous fishery.

Temperature recommendations for fishery enhancement in the Calapooia River have been set at 55^{0} F. from October 1 to May 30 and 60^{0} F. from June 1 to September 30. During an average year, water temperatures 13.5 miles below the project site will exceed the recommended values from mid-April to the end of October. Immediately below the dam the temperatures will exceed the recommended values during the month of October. For the minimum hydrologic year, temperatures at Brownsville will exceed the recommended limits for the same April-October period. Temperatures immediately below the dam, however, will exceed recommendations from mid-July to mid-October.

3. A need for municipal and industrial water supplies for the Holley-Brownsville area in excess of present source capacity will develop by 1980 and continue to increase throughout the study period.

Recommendations

1. The Corps of Engineers include municipal and industrial water supply as a project function for Holley and reserve space sufficient to yield an average 1.3 million gallons per day (mgd). The current annual value of this storage is estimated to be $42,000.

2. Recreation development on Holley Reservoir have adequate sanitary facilities with no discharge to the reservoir surface waters.

3. Construction of the project provide for adequate protection of water quality from siltation or other influences.

STUDY AREA DESCRIPTION

Geography and Climate

The study area for this report is the Calapooia River drainage basin, including the adjacent Halsey area west of Brownsville. The Calapooia River drains a narrow area between McKenzie River Basin on the south and the Santiam River Basin on the north. The upper portion of the basin area . mountainous and heavily timbered. The lower portion of the basin is flat, mostly agricultural land with slopes as low as 2.5 feet per mile.

CALAPOOIA RIVER BASIN

FIGURE 1.

The climate of the study area is of the temperate maritime type, characterized by dry, moderately-warm summers and wet, mild winters. Headwaters of the Calapooia River are in one of the wettest areas of the Willamette River Basin. Although the normal annual precipitation at the Holley Dam site is about 56 inches, that of the headwaters region exceeds 110 inches. The normal annual precipitation for the watershed averages approximately 80 inches. The temperatures of the basin are moderate except for occasional short periods of hot or cold weather. The temperature extremes at Albany, near the mouth of the Calapooia River, have ranged from 104° minus 15° F. Growing season in the agricultural areas varies from 180 to 200 days.

Economy

Present

The economic growth of the Calapooia area has historically been based on timber and agriculture. Although diversification has taken place in recent years, these two natural resource related industries continue to provide the impetus for over-all growth and development. Timber harvesting and lumber production reached peak levels between 1943 and 1956. Since 1956, there has been a sharp decline in lumber production, although the plywood and wood fiber industries have continued to expand.

Lumber and wood-products manufacturing are presently the largest industries in the basin. Economic activity centers around Brownsville, the basin's largest community, where several sawmills (employing about 125 persons) and a small particle board plant are the major employers. Near Halsey, a new bleached-kraft pulp mill is now in operation with a potential employment of over 400.

There has been some decrease in total farm acreage during the past 30 years, but an increase in cropland acreage. Most of this increase has been in vegetables, with a decrease in small grains, tree fruits, and nuts. The foremost crop in the area is seed grass. A seed warehouse in Halsey is one of the largest in the Willamette Basin and one of the town's principal employers.

The Calapooia Basin reflects the national trend toward a decrease in rural population. At the present time, however, the majority of people continue to live on farm sites. The total population in the Calapooia River Basin in 1960 was 8,800.

Table 1 shows the 1950 and 1960 population of incorporated towns in the Calapooia Basin.

TABLE 1
POPULATION OF INCORPORATED PLACES
CALAPOOIA RIVER BASIN

Location	1950	1960
CALAPOOIA RIVER BASIN:		
Brownsville	1,175	875
Halsey	388	404
Sodaville	157	145

Source: U. S. Census of Population, 1950 & 1960.

Future

The economic future will most likely follow existing trends. Some increase in the timber harvest due to maturing of second-growth stands may be expected and, with the expansion of this resource, the basin's forest-products industries will grow. Capacity at the sawmill in Brownsville should increase, and increased capacity at the particle board plant also seems likely. Agricultural production is expected to increase due to expanded irrigation and improved productivity. With increased irrigation, a more diversified agricultural base, with greater emphasis on dairying and vegetable crops could logically develop. This will provide the resource for an increased service industry at Brownsville and Halsey. Some spill-over of the growth anticipated for urban areas of Linn (particularly Albany) and Lane Counties may add to the basin's growth. Development of a substantial manufacturing industry appears unlikely.

The Holley Reservoir Project and its possible influence on irrigation is the principal modifying factor to be considered in gaging the future of the Calapooia Basin. The history of other irrigation developments indicates that additional irrigation will slow the downward course of rural population. Large agricultural outputs are more likely to result in expansion of food-processing activities in the Salem or Albany service area than in establishment of processing in the Calapooia River Basin.

The Bureau of Reclamation anticipates eventual irrigation service to 42,000 acres of new land in the Calapooia Basin. The servicing of organized districts is expected to be gradual with full service in about 20 years.

In the past few years, a leveling off in production of timber products has been experienced within the middle Willamette Basin (from the Long Tom to the Tualatin). It is probable that a plateau has been reached and will continue during the next 20 years. Timber lands should be near sustained-yield levels at about the end of the study period.

Neither the recent history of the Calapooia Basin area nor the prospects of economic development outlined above suggests vigorous population expansion during the study period. Most of the growth in the basin is predicted to occur at Brownsville. While the rural population is forecasted to remain around 7,000, it is anticipated that the present Brownsville population will triple by 1985. The other incorporated places in the basin will increase slightly but not significantly. Table 2 shows the projected population for the Calapooia Basin.

TABLE 2
PRESENT AND PROJECTED POPULATION
CALAPOOIA RIVER BASIN, OREGON
1960, 1985, & 2010

Location	Population in Thousands		
	1960	1985	2010
Brownsville	1.0	3	6
Halsey	0.4	1	2
Holley-Crawfordsville	0.2	1	1
Sodaville	0.2	0.5	1
Rural Area	7.0	7	7
TOTAL, Calapooia River Basin	8.8	12.5	17

PROJECT DESCRIPTION

The proposed Holley Dam and Reservoir Project is located in the headwaters of Calapooia River, a tributary of Willamette River in northwestern Oregon. The development would include construction of Holley Dam located on Calapooia River about 46 river miles upstream from the confluence of Calapooia and Willamette Rivers at Albany, Linn County, Oregon. The reservoir would be operated primarily for flood control with provisions for irrigation, navigation, municipal and industrial water supply, reservoir recreation, fish conservation including fish ladder operations at Willamette Falls, and fisheries enhancement. The project would be coordinated with existing, authorized and planned development of the total Willamette River system.

Holley Reservoir would have a total storage capacity of about 145,000 acre-feet. Space for some carryover storage is included to provide supplemental water for irrigation and fish life during extreme dry years. Principal features of the proposed dam and reservoir are shown in Table 3.

TABLE 3
PRINCIPLE FEATURES OF HOLLEY
DAM AND RESERVOIR

	Elevation (Feet)	Surface Area (Acres)	Storage (Ac.-Ft.)
Top of Dam	684	--	--
Maximum Pool	679	2,680	145,000
Maximum Conservation Pool	677	2,620	139,500
Minimum Conservation Pool	634	1,450	51,000
Streambed	530	--	--

The reservoir would inundate about 5 miles of Calapooia River. The spillway would be a gate-controlled-ogee crest type and flood discharge works would consist of two tainter gates. The outlet works would include multiple intakes. Maximum flood control space would be provided from November 16 through January 31.

Channel improvement work on Calapooia River is also included in the plan. This includes downstream channel clearing, bank revetment, new channels, and a flow control structure at the head

of Sodom Ditch. The downstream work would eliminate several oxbows from the main river channel.

Fish and wildlife conservation and enhancement measures proposed for this project include: facilities for upstream and downstream passage of anadromous fish at Holley Dam, facilities for upstream fish passage at the flow control structure on Sodom Ditch, augmentation of low summer flows, and water temperature control.

An irrigation development has been planned, in conjunction with the Holley Project, for lands lying between Holley Reservoir and Brownsville. These lands cannot be adequately served by a water supply from any source except Holley Reservoir. The Bureau of Reclamation presently expects that an economic irrigation project of 8,700 acres will be constructed, where water would be pumped from the Calapooia River and distributed by pipeline.

Streamflows have been recorded for the Calapooia River at Holley since 1935 and at Albany since 1940 (see Figure 2, Schematic Diagram). A summary of these data is included in Table 4. A low flow frequency analysis was performed using the mean annual flows of record at Holley and Albany for the twenty-three years from 1941 to 1963, inclusive. A distribution of mean monthly low flow with recurrence intervals of 5, 10, and 20 years was developed and is listed in Table 5. The natural mean monthly low flow of the river at Brownsville, with a recurrence frequency of one-in-ten years, adjusted for full exercise of irrigation diversion rights is estimated to be approximately 46 cfs.

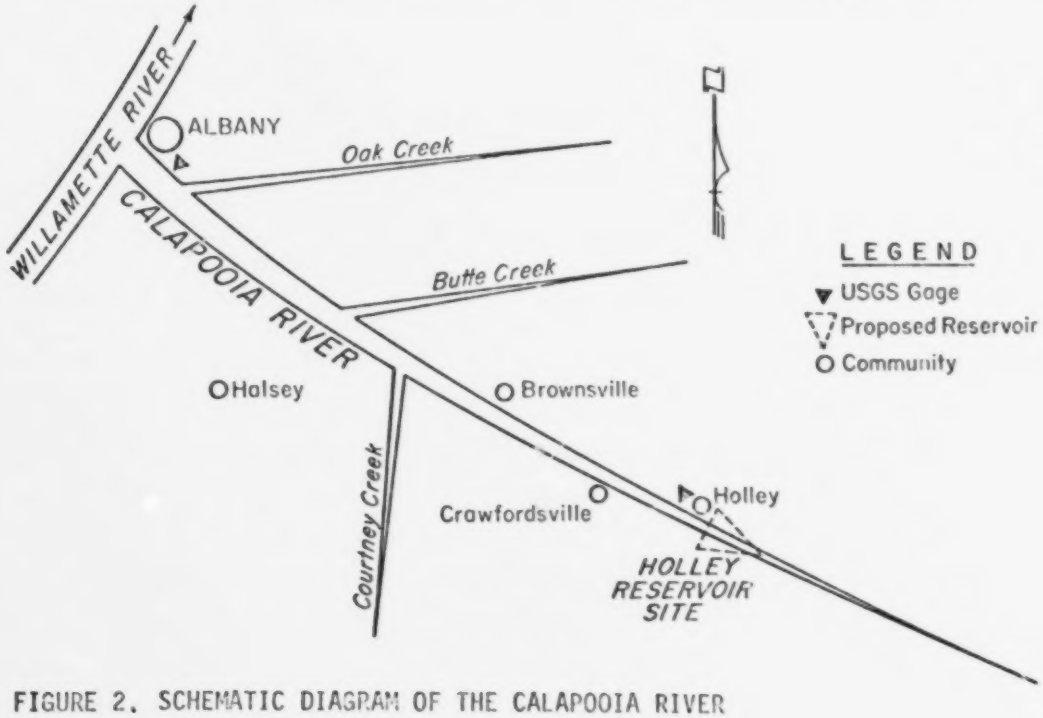

FIGURE 2. SCHEMATIC DIAGRAM OF THE CALAPOOIA RIVER

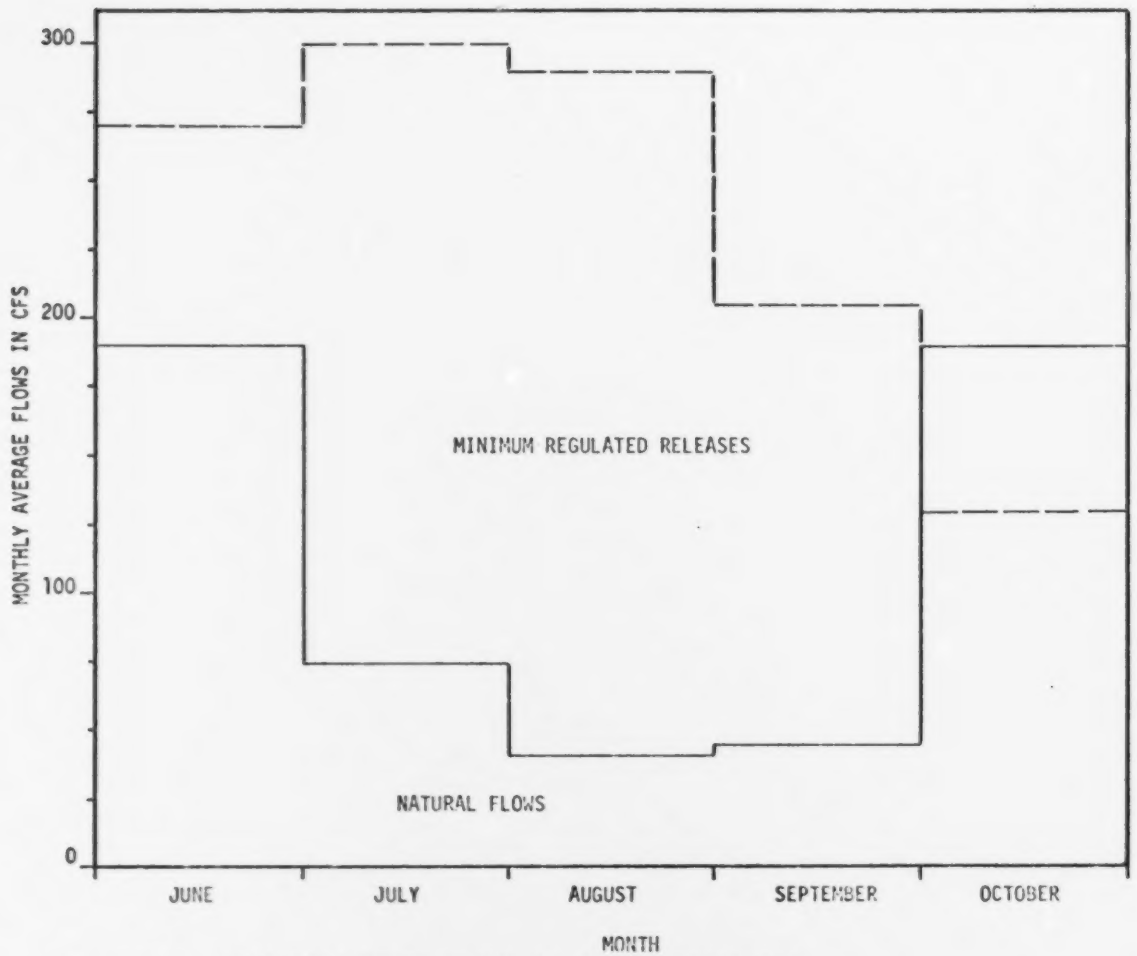

FIGURE 3. CALAPOOIA RIVER FLOWS AT HOLLEY RESERVOIR

Ground Water

Ground water in the Calapooia River Basin is an important complement to the surface water resources of the area. Most of the rural domestic water needs are supplied by ground water. The greatest use of ground water in Calapooia Basin is for irrigation. Irrigation rights presently total about 16 cfs.

Ground water is relatively abundant in the basin due in large part to the occurrence of coarse, permeable, and relatively silt-free alluvium derived from the volcanic rocks of the Cascade Range. The yield capability of wells is lowest in the area east of Brownsville. In the western part of the basin, the well supplies generally yield up to several hundred gallons per minute (gpm). The highest yields (up to 1,000 gpm) occur along lower reaches of Calapooia River and along Oak Creek.

Preceding page blank

WATER RESOURCES

Surface Water

Water resources development in the Calapooia Basin is closely related to land utilization. In general, land use upstream from Holley is almost exclusively devoted to forestry, while a considerable portion of the downstream area of the Calapooia Basin has been developed for agriculture. No major storage reservoirs have been constructed in Calapooia Basin.

Basin lands have been irrigated to varying degrees since about 1905. The Calapooia River is an adjudicated stream serving over 100 individual water rights for the irrigation of approximately 2,200 acres. These rights total about 24.5 cfs. Brownsville has a surface water right of 0.67 cfs for municipal purposes.

Streamflows have been recorded for the Calapooia River at Holley since 1935 and at Albany since 1940 (see Figure 2, Schematic Diagram). A summary of these data is included in Table 1. A low flow frequency analysis was performed using the mean annual flows of record at Holley and Albany for the twenty-three years from 1941 to 1963, inclusive. A distribution of mean monthly low flow with recurrence intervals of 5, 10, and 20 years was developed. The natural mean monthly low flow of the river at Brownsville, with a recurrence frequency of one-in-ten years, adjusted for full exercise of irrigation diversion rights is estimated to be approximately 46 cfs.

Figure 3 shows the present natural flows during the low flow period compared with the proposed regulated flows from Holley Reservoir at the damsite.

Ground Water

Ground-water quality in the Calapooia Basin is generally suitable for both domestic and irrigation uses. Many wells, however, are shallow and receive surface seepage, thereby being susceptible to sewage infiltration. Mineral contamination and surface pollution of ground water restrict use or necessitate treatment before use in some areas. In these areas, wells drilled deeper than 100 feet often tap water with an excessive salt content which makes it unfit for domestic or irrigation use. Hardness is also excessively high.

TABLE 4
RECORDED STREAM FLOW DATA
CALAPOOIA RIVER BASIN, OREGON

	HOLLEY	ALBANY
Station No.	14-1720	14-1735
Elevation, Ft.	527.58	180.85
Drainage Area, Sq. Mi.	105	372
Record	Sept 1935-Sept 1965	Oct 1940-Sept 1965
Average Discharge, cfs	450	929
Average Discharge, acre-feet	325,800	672,600
Maximum Day, cfs	12,600 Dec 22, 1964	32,700 Dec 22, 1955
Minimum Day, cfs	13 Sept 8, 1940	4 Oct 7, 1952
Regulation above Station	None	None
Diversions above Station	None	Approx. 2,700 acres irrigated

Source: U. S. Geological Survey - Water Supply Papers

TABLE 5
MEAN MONTHLY LOW FLOWS AT VARIOUS RECURRENCE FREQUENCIES
CALAPOOIA RIVER BASIN, OREGON
(cfs)

MONTH	HOLLEY [a] Recurrence Interval, Years				BROWNSVILLE [b] Recurrence Interval, Years			ALBANY [c] Recurrence Interval, Years		
	5	10	20	30	5	10	20	5	10	20
Jan.	620	519	438	400	862	719	610	1266	1080	932
Feb.	700	585	494	452	973	811	689	1345	1148	989
Mar.	553	461	390	356	768	640	544	945	806	695
Apr.	430	361	304	278	599	499	424	605	516	445
May	282	236	199	182	392	326	277	367	313	270
June	142	119	100	92	197	164	140	144	122	106
July	57	47	40	36	96	80	68	56	48	41
Aug.	32	26	22	20	55	46	39	26	22	19
Sept.	34	29	24	22	61	51	43	29	24	21
Oct.	146	122	104	94	203	169	144	158	135	116
Nov.	474	396	335	306	660	550	467	709	605	521
Dec.	696	581	491	449	968	806	685	1220	1040	897
Mean	347	290	245	224	486	405	344	680	580	500

---

a/ Natural Runoff
b/ Estimated -- Adjusted for Irrigation Diversions
c/ Not Adjusted for Diversions

WATER USES

Municipal and Industrial Water Supply

Present Water Use

Communities within service range of the proposed Holley Reservoir are Holley, Crawfordsville, Brownsville and Halsey. The City of Albany, located at the mouth of the Calapooia River, obtains its water supply from the South Santiam River outside of the study area.

The greatest demand for M&I water in the Calapooia Basin occurs at Brownsville. The Brownsville municipal water facility serves approximately 1,000 persons at the average rate of 140,000 gallons per day (gpd), or 155 acre-feet per year. Water is obtained from an infiltration gallery on the Calapooia River. The minimum daily flow recorded for the Calapooia River at Brownsville is approximately 13 cfs (8.4 mgd). The water plant has a rated capacity of 720,000 gpd (1.1 cfs). Brownsville has surface and ground-water rights of 430,000 and 320,000 gpd, respectively. Chemical analyses indicate a relatively good quality water at Brownsville. Chlorination is the only treatment practiced.

At Halsey, the Citizens Water and Light Company provides water from a well to serve approximately 200 persons at the average rate of 20,000 gpd, or 22 acre-feet per year. The well has a rated capacity of 50 gpm. The present demand averages about 20,000 gpd, or 14 gpm. Difficulties have been experienced in developing well supplies in this area due to limited yields and high solids content.

Holley, Crawfordsville, Sodaville, and other small communities within Calapooia Basin have not yet developed community water supply systems. Residents of these smaller communities, as well as people living in rural areas, are supplied by wells and other individual facilities.

No significant amount of surface or ground water is being used exclusively for industrial purposes in the Calapooia Basin.

TABLE 6
MUNICIPAL AND INDUSTRIAL WATER DEMAND
CALAPOOIA RIVER BASIN, OREGON
1960, 1985, & 2010

Community	Year	Population Served (1000's)	Ave. Annual Demand (mgd)	Maximum Demand Monthly (mgd)	Maximum Demand Daily (mgd)
Brownsville	1960	1	0.14	0.26	0.4
	1985	3	0.60	1.1	1.6
	2010	6	1.35	2.6	3.6
Halsey	1960	0.2	0.02	0.04	0.06
	1985	1	0.20	0.4	0.5
	2010	2	0.45	0.8	1.2
Holley-Crawfordsville	1960	0	0.00	0.0	0.0
	1985	1	0.20	0.4	0.5
	2010	1	0.23	0.4	0.6
Sodaville	1960	0	0.00	0.0	0.0
	1985	0.5	0.10	0.2	0.3
	2010	1	0.23	0.4	0.6

Future Water Needs

Population growth (Table 2) and data showing increasing per capita water demands indicate that requirements for M&I supply will exceed present supplies within the study period. Based on trends toward higher over-all per capita demands in the Willamette Basin, the estimated daily per capita demand by 1985 will be about 200 gallons and by 2010 about 225 gallons. Applying these values to expected municipal populations in the Calapooia area, the projected annual requirements are computed as shown in Table 6. The expected monthly distribution of the requirements for Brownsville is shown in Table 7.

Study area water demands for the respective years 1985 and 2010 are projected to total 1.10 and 2.26 mgd. Demands in areas within range of Holley Reservoir for these years are 1.0 and 2.03 mgd, respectively. About 65 percent of this demand is expected to occur at Brownsville.

TABLE 7
PROJECTED AVERAGE MONTHLY M&I WATER DEMAND AT BROWNSVILLE
CALAPOOIA RIVER BASIN, OREGON
1985 & 2010

Month	1985 Percent of Avg. Annual Demand	1985 Demand (mgd)	2010 Percent of Avg. Annual Demand	2010 Demand (mgd)
January	70	0.42	68	0.92
February	68	0.41	72	0.96
March	69	0.41	74	0.99
April	75	0.45	79	1.06
May	105	0.63	83	1.11
June	166	1.00	132	1.76
July	191	1.15	195	2.62
August	138	0.83	158	2.11
September	89	0.53	106	1.42
October	79	0.47	86	1.15
November	76	0.46	76	1.04
December	74	0.44	71	0.96
AVERAGE	100	0.60	100	1.35

There is a need for additional water supplies to supplement existing municipal supplies in the Brownsville and Holley areas and to replace ground-water supplies at Halsey. Stored water in Holley Reservoir in lieu of local source development in Calapooia Basin or pumpage from Willamette River would offer economic advantage through incremental cost-sharing in the multi-purpose project as well as to provide these communities with a dependable water supply of relatively uniform quality.

The annual need for stored water in Holley Reservoir by the year 2010 to supplement existing water rights and to replace the Holley ground-water supply is that required to yield 1.3 mgd. This excludes 0.75 mgd available supply at Brownsville, but includes total supply at Holley-Crawfordsville and Halsey. First need could begin at the time of project completion (1975) when summer demands are expected to exceed water rights and when transmission and treatment facilities at Halsey could be completed for operation. The annual value of this storage as estimated on the basis of least-cost single-purpose construction amortized on a 100-year basis at 4 5/8% interest is $42,000.

Fishery

One of the outstanding uses of the Willamette River and its tributaries is the production of anadromous fish for the sport fishery of the Willamette River and the sport and commercial fisheries of the Columbia River and the Pacific Ocean. Spring chinook salmon and steelhead trout are the anadromous fish utilizing the Calapooia River as a spawning and rearing area. Little spawning occurs in Calapooia River downstream from Holley damsite, but about 300 spring chinook salmon annually pass Holley damsite to spawning grounds upstream from the reservoir boundaries. More than 2,000 steelhead trout presently pass Holley on their spawning migration and 400 spawn within the proposed reservoir limits.

Cutthroat trout are the most abundant resident game fish in Calapooia River upstream from the reservoir site. Stocks are well above the average for streams in upper Willamette Valley. Also, migratory cutthroat trout from the Willamette and lower Calapooia Rivers spawn upstream from the damsite. Resident and hatchery-reared rainbow trout and mountain whitefish also contribute to the sport catch.

Non-game fish present include suckers, squawfish, dace, sculpins, shiners, and lampreys. Populations of squawfish do not extend far above the reservoir site.

Recreation

Fishing, camping and picnicking are the primary water-oriented recreation activities undertaken here. Private ownership of adjacent lands to the river downstream from Holley, in addition to the low population concentrations in proximity to the basin, have limited the numbers of recreationists.

The reservoir will offer an attractive recreation resource to the basin. As population and participation in water-related recreational activities increase in the future, recreation use in the Calapooia will also significantly increase.

Irrigation

Most of the presently irrigated lands in the Calapooia Basin are located along the river between Holley and just below Brownsville and total around a few thousand acres. It is expected that some 42,000 acres more will eventually be irrigated in the basin. Water application will be primarily through sprinkler systems. Irrigation is expected to change crop patterns from reliance on specialty seed crops to a major proportion of pasture, hay and silage.

WATER QUALITY

The water quality appraisal is based upon a comparison of what the water quality is predicted to be and what it should be. The Oregon State Standards as well as special recommendations for anadromous fish are first described to establish what the water quality should be. Next, to support the predictions of future water quality, the types and quantities of waste inputs to the Calapooia River are reported. The river's present quality, resulting from waste inputs and hydrologic conditions, is presented as a base from which the future quality is predicted.

Predictions are presented of future quality; (1) assuming the dam is not constructed and (2) assuming that the dam is constructed and operated as proposed for irrigation and fish purposes. Dissolved oxygen and water temperature are the parameters predicted. The results of these predictions are evaluated in a brief summary.

Water Quality Requirements

The Oregon Environmental Quality Control Commission has established general Water Quality Standards which apply to the Calapooia River. These standards--which indicate minimum levels of acceptable water quality--state in part: "No wastes shall be discharged and no activities shall be conducted which, either alone or in combination with other wastes or activities, will cause...:

1. The dissolved oxygen content...to be less than six (6) mg/l...

4. The development of fungi or other growths having a deleterious effect on stream bottoms, fish or other aquatic life, or which are injurious to health, recreation or industry.

7. Objectionable discoloration, turbidity, scum, oily slick or floating solids, or coat aquatic life with oil films.

8. Bacterial pollution or other conditions deleterious to waters used for domestic purposes, livestock watering, irrigation, bathing...or be otherwise injurious to public health."

(On comparable streams, the standards state: "Average concentrations of coliform bacteria not to exceed 1,000 per 100 ml, with 20% of samples to exceed 2,400 per 100 ml.")

Stream flow regulation evaluations also consider those special water quality requirements which are of primary importance to specific water uses and which can be controlled by releases of water from storage. For the Calapooia River, these major indicators of quality are dissolved oxygen (as influenced by biochemical oxygen demand) and temperature. The uses associated with these major indicators are fish life, water recreation, and stream aesthetics. Bacterial quality, although important, is not usually amenable to control by flow regulation, but rather by waste disinfection at the source or controls of animal feed lots, grazing and watering places on land. Mineral and nutrient concentrations can often be improved at levels of flow required to control dissolved oxygen and temperature.

Dissolved Oxygen

The dissolved oxygen (DO) objective is governed by anadromous fishery requirements--the use requiring the highest level of quality. Other uses served at this level are recreation and other water based activities for which aesthetic conditions are important.

Calapooia River above Butte Creek (R.M. 19.8) provides spawning and rearing habitat for salmon and steelhead requiring DO levels of greater than 7 mg/l. Below Butte Creek, the Calapooia River is sluggish and unsuited for fish spawning and rearing. This reach requires a DO of 6 mg/l.

Temperature

Temperature recommendations are also governed by the anadromous fishery. Recreation and general stream conditions, including greater capacity to assimilate wastes, are also dependent upon water temperatures. The Fish and Wildlife Service has recommended controlled water temperatures to provide improved spawning, hatching and rearing environments of less than 55° F. from October 1 to May 31 and less than 60° F. from June 1 to September 30.

Waste Inputs

Present and potential municipal and industrial waste discharges are major considerations in establishing needs for water quality control. Water pollution measured in terms of organic waste demands on the dissolved oxygen (DO) resource of stream waters compared with DO requirements dictate the level and types of control required.

Present Waste Loads

The community of Brownsville is the largest single source of municipal and industrial waste. Municipal waste in this area having an untreated population equivalent of 600 is collected and treated by lagoon stabilization. The resulting total daily load to the Calapooia River, including industrial particle board plant waste, is estimated to be 220 PE.

Future Waste Loads

Future waste load projections are based upon information presented in the economy section. The combined municipal and industrial loading expected along the Calapooia River for the years 1985 and 2010 are 800 and 1,300 PE, respectively. The loadings assume provisions for adequate treatment. A base of adequate treatment is effective waste collection and secondary treatment for domestic wastes and equivalent reduction of industrial waste loads by a combination of process control, internal waste savings, water reuse and effluent treatment. At the present time, it is reasonable to expect an over-all equivalent of 85 percent BOD removal in a well-operated sewage collection and treatment system. In this study area, it is believed that BOD reductions of 85 and 90 percent are feasible for the years 1985 and 2010, respectively.

It is also well known that irrigation return flows carry an organic load similar in effect to domestic wastes upon dissolved oxygen levels in the receiving stream. The magnitude of this organic load source has not been estimated in this study. Therefore, the future waste loads used in the computations of water quality are probably conservative.

TABLE 8
SURFACE WATER QUALITY AT ALBANY
CALAPOOIA RIVER BASIN, OREGON

Date	7/30/57	8/6/57	8/13/57	8/20/57	8/27/57	9/3/57	8/8/62	8/21/62	9/12/62	8/17/65
Time	--	--	--	--	--	--	0915	1000	0845	--
Analysis by	DEQ	DEQ	DEQ	DEQ	DEQ	DEQ	PHS	PHS	PHS	DEQ
Temp. $^{o}F.$	71.5	68	70.5	70	--	70	64	68	60.5	77
pH	6.9	7.2	7.2	7.2	--	7.3	7.6	7.7	7.5	7.3
DO, mg/l	8.4	8.4	8.5	7.8	8.9	8.5	8.8	8.1	8.8	7.6
% Sat.	95	92	95	87	--	95	92	89	89	90
BOD_5, mg/l	0.7	0.4	0.4	0.3	1.0	0.1	0.5	0.7	0.6	0.4
MPN	2400	2300	620	2400	620	2400	4100	2900	1030	600
Fecal Coli	--	--	--	--	--	--	500	500	100	--
Strep MF	--	--	--	--	--	--	96	280	140	--
Flow, cfs	59	56	60	43	30	21	70	40	42	36

Note: DEQ - Oregon Department of Environmental Quality
PHS - U. S. Public Health Service

Present Water Quality

In the previous sections it has been shown that very limited economic development has occurred in this basin. No sizeable industry is located here, there are few people and many of them operate farms. Irrigation development has not been sizeable. Wastes from these activities have been small, and those collected are given adequate treatment prior to discharge to the Calapooia. Water quality degradation in the Calapooia River has thus been minor. Measurements of quality support this observation. The physical and chemical quality of water above the proposed reservoir is excellent. At times, however, sediment concentrations are sizeable with a peak estimated load of 90,000 tons per year at Albany. Activities such as logging, road construction, and gravel washing occasionally contribute substantial sediment loads to the stream which can damage fish spawning and propagation. No significant sources of organic waste exist above the site.

The Calapooia below the site is also low in organic matter (5-day BOD of 1.0 mg/l or less). Recorded dissolved oxygen (DO) levels are above the standards of 6 mg/l and, as shown in Table 8, normally exceed 8 mg/l. Coliform densities increase to recorded levels ranging between 620 and 4,100 organisms per 100 ml.

The main stem Calapooia River below Brownsville is a low gradient, sluggish stream. Summer water temperatures here normally exceed 70° F.

Future Water Quality

Estimates of future conditions here do not show significant changes in those factors that affect water quality. Economic growth will be slow and no new major waste-producing industry is expected. New irrigation will develop slowly, utilizing sprinkler applications, and is expected to result in minimal return flows to the stream.

These factors, as well as others, were applied to a dissolved oxygen and a temperature model of the river to aid in predicting the future water quality of the river. Among the other factors were included: (1) projected levels of waste treatment efficiency applied to collected wastes in the basin, and (2) flows at various points in the river under project conditions.

The preliminary temperature evaluation, prepared in 1966 for use in early project planning, was based upon extrapolation of data from other Willamette reservoirs. Much progress has been made recently in temperature prediction capability. Present temperature evaluations are prepared from a computerized model and use more advanced techniques in predicting reservoir temperature patterns.

Without Project Development

The quality of the Calapooia is not expected to change appreciably from present conditions. The limited projected development here would not seriously affect dissolved oxygen or other conditions. Flows would remain comparable to past flows, and summer water temperatures in the lower reaches would continue to exceed the desired fishery levels.

With Project Development

The increase in summer flows shown in Figure 3 would cause a general improvement in stream quality conditions. However, since the stream meets State standards without the project, the value of the improvements would be incidental to the beneficial uses served.

The proposed anadromous fishery enhancement through project modification of flows depends upon maintenance of adequate dissolved oxygen and temperature.

Predictions of Dissolved Oxygen

Within the proposed reservoir, dissolved oxygen depletion is not expected to be significant. Some algal growth will occur in the epilimnion during summer months, but the effect upon the dissolved oxygen concentration in the hypolimnion should be such that levels will remain above 6 mg/l at all times. With this concentration in the reservoir release, downstream oxygen levels will differ little from those found without the project.

Predictions of Water Temperature

Predictions of water temperature were made for both the reservoir and downstream conditions. These predictions are based upon the model developed by Water Resources Engineers, Inc. and a river run model developed by the Northwest Region of FWPCA. Reservoir water temperatures were estimated assuming a single outlet at elevation 545; average monthly Albany weather data for 10 years of record; a typical hydrologic year of 1958 and a mini-

mum hydrologic year of 1941; and the simulated reservoir operation schedule including outflow for the years of investigation provided by the Corps of Engineers. Expected reservoir releases for hydrologic years 1958 and 1941 are shown on Figure 4.

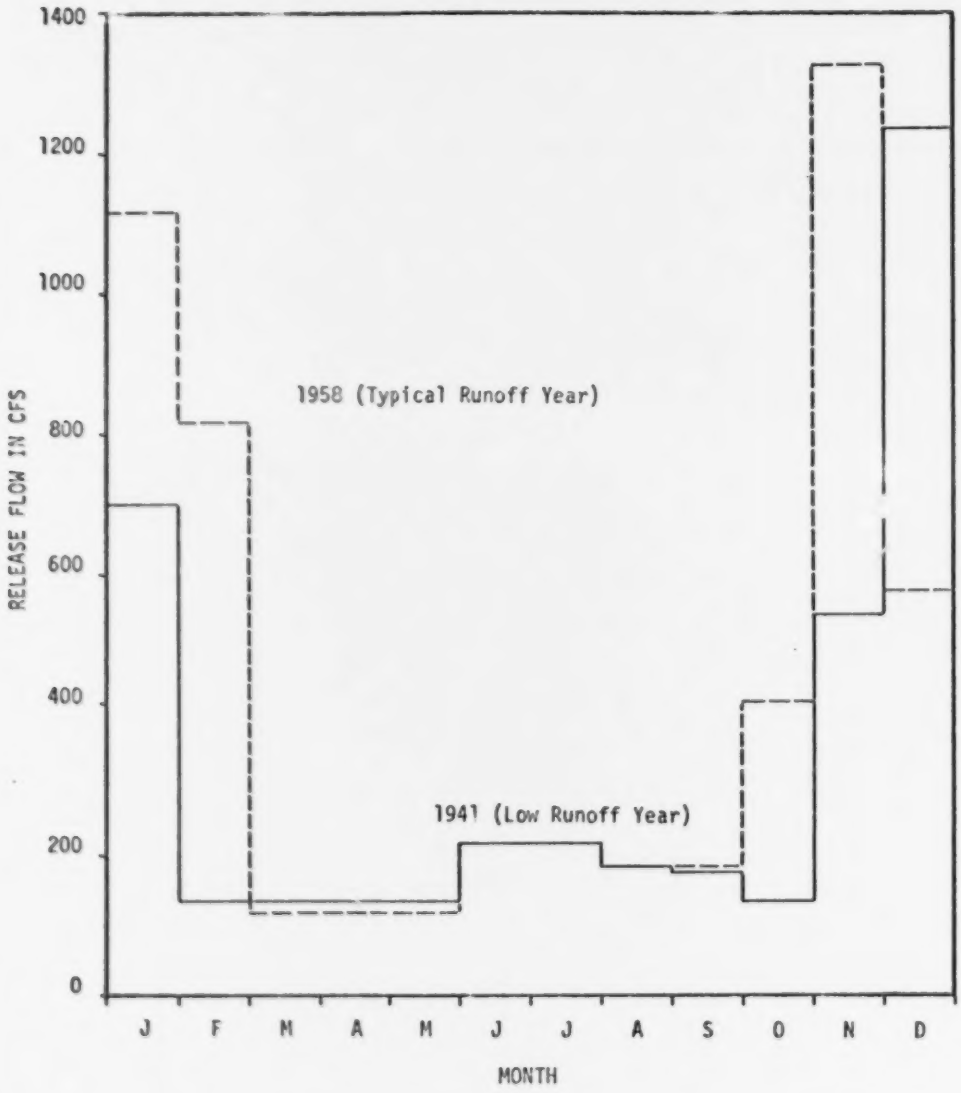

FIGURE 4. HOLLEY RESERVOIR REGULATED RELEASE FLOWS

Isotherm patterns in Holley Reservoir for the average hydrologic year (1958) are shown on Figu 5. Hypolimnion temperatures near the outlet are expected to approach 60° F. in mid-October of a hydrologic year similar to 1958 and would approach 68° F. during August of a minimum hydrologic year similar to 1941. Multi-level outlet operation would not reduce the October release temperatures more than 1° F. due to the reservoir regulation characteristics.

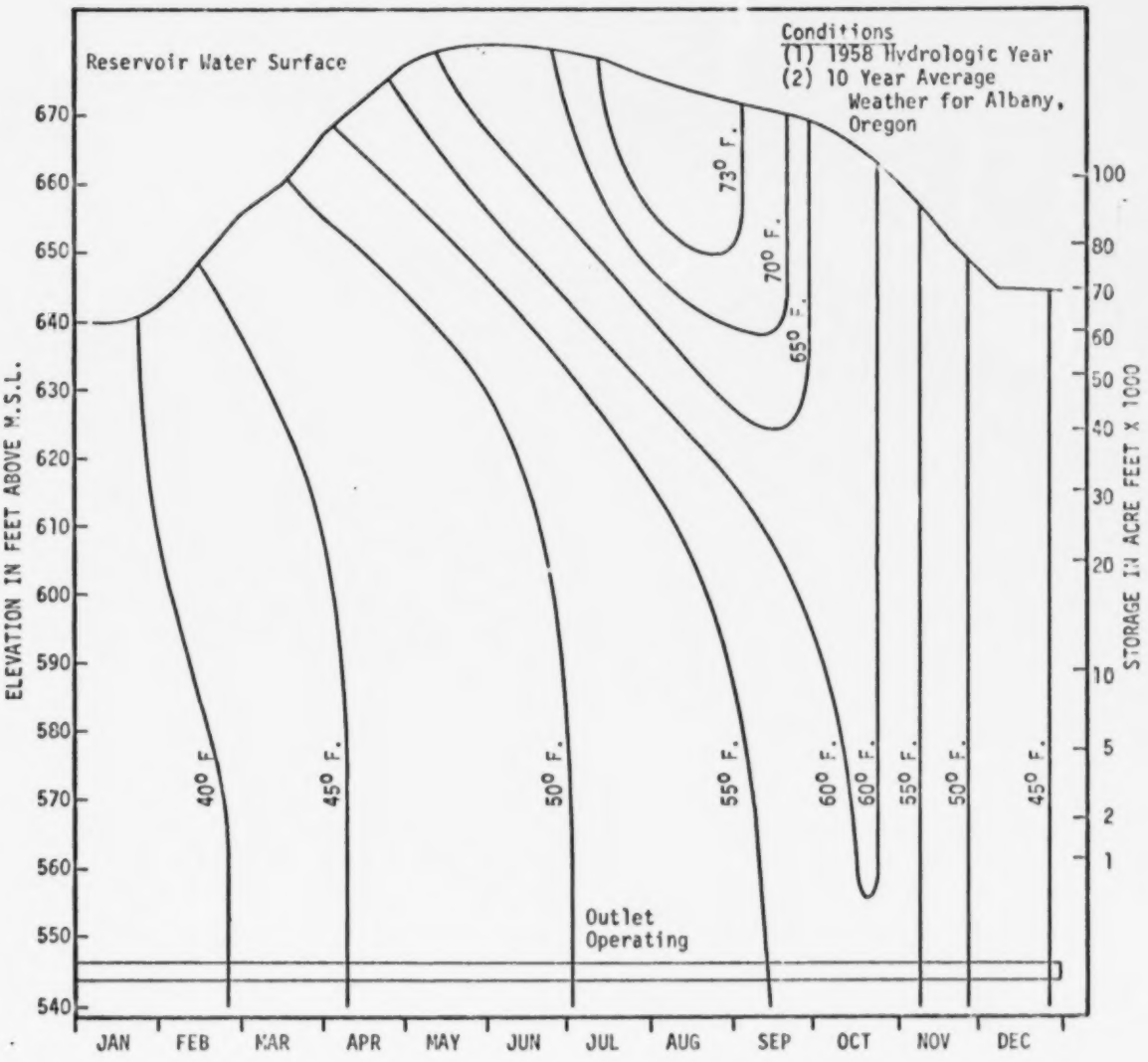

FIGURE 5. PREDICTED HOLLEY RESERVOIR ISOTHERMS - CALAPOOIA RIVER

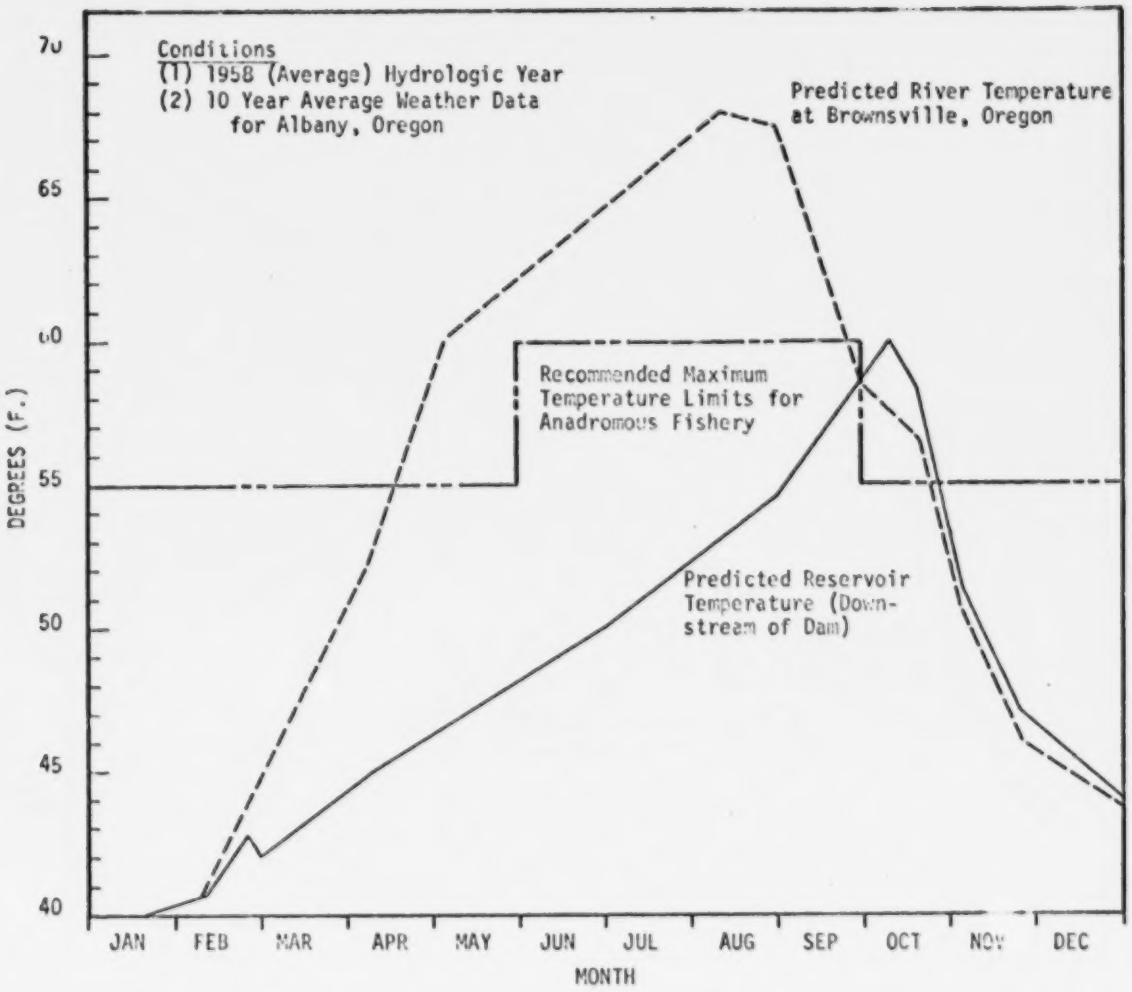

FIGURE 6. CALAPOOIA RIVER TEMPERATURES - AVERAGE HYDROLOGIC YEAR

Temperatures just downstream from Holley Dam and at Brownsville 13.5 miles downstream are shown on Figures 6 and 7 for the 1958 (average year) and 1941 (minimum year) conditions, respectively. Figure 6 shows that, during an average hydrologic year, the water temperature requirements at Brownsville would be exceeded from about April 15 to the end of October. Maximum water temperatures at Brownsville are predicted to be 68^{0} F. during August.

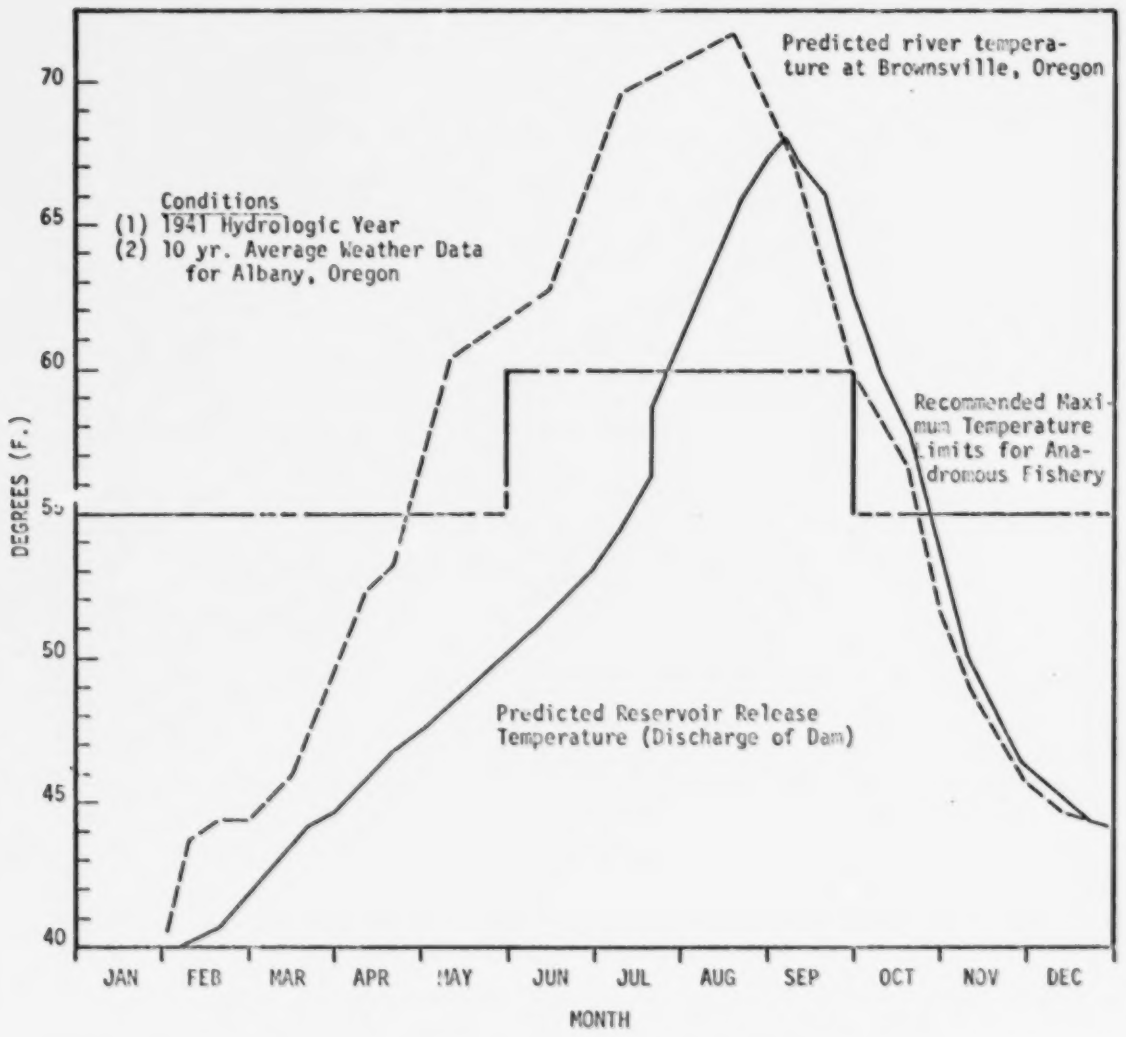

FIGURE 7. CALAPOOIA RIVER TEMPERATURES - MINIMUM HYDROLOGIC YEAR

Figure 8 shows the predicted average monthly temperature profile for the 13.5 mile reach from Holley Dam to Brownsville for July, the warmest month of an average and minimum hydrologic year. It is seen from Figure 8 that predicted water temperatures are below the recommended fishery limit of 60° F. downstream of Holley Dam for only the first 2.5 miles for the minimum year and 5.0 miles for the average year, even though the reservoir release temperatures are below 60° F. Predicted temperatures at Brownsville are above 67° F.

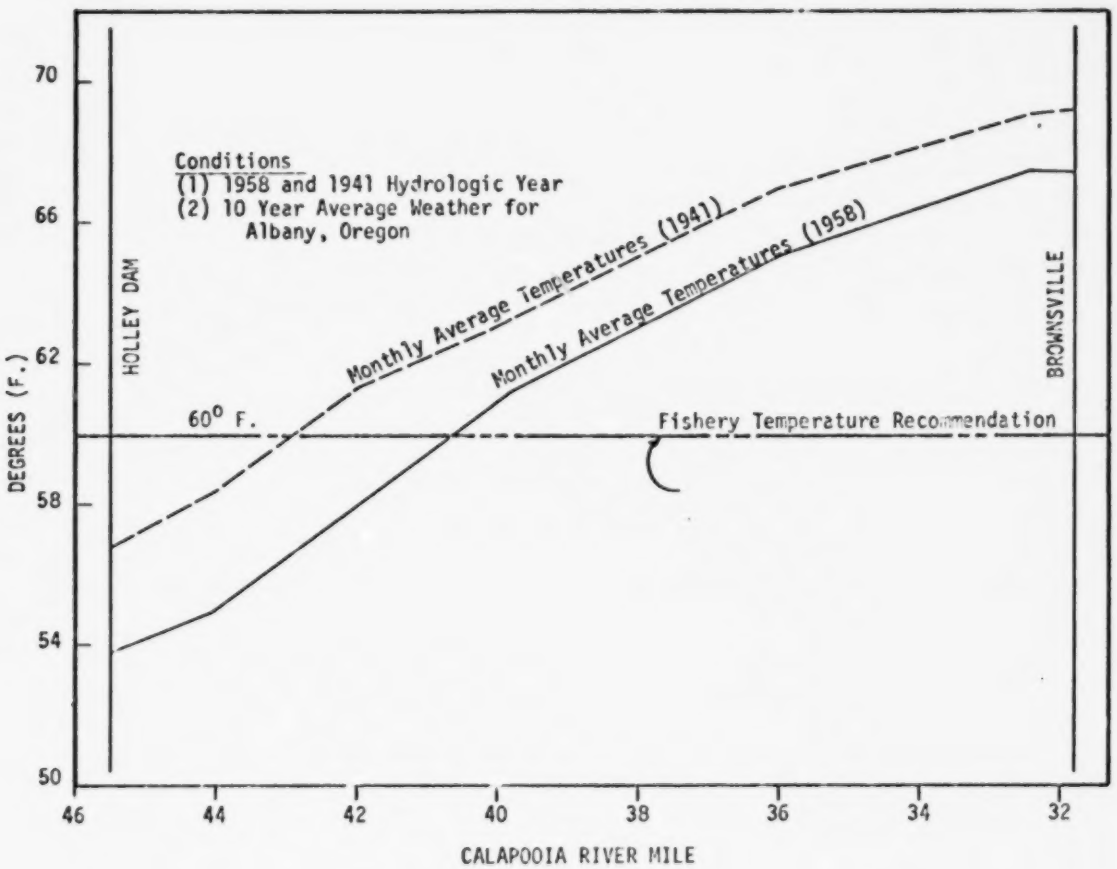

FIGURE 8. JULY TEMPERATURE PROFILES - CALAPOOIA RIVER

Figures 9 and 10 depict weekly average temperature profiles for the same 13.5 mile reach during the spawning season from September 1 to October 15 of an average hydrologic year. For average conditions, predicted reservoir release temperatures during September range from 55° F. to 57° F. while downstream temperatures approach 60° F. within 6 miles of the dam and range from 61° F. to 64° F. at Brownsville. For October, predicted temperatures are above the recommended limit of 55° F. for the entire 13.5 mile reach. Reach temperatures during this period were not computed for the minimum (1941) year.

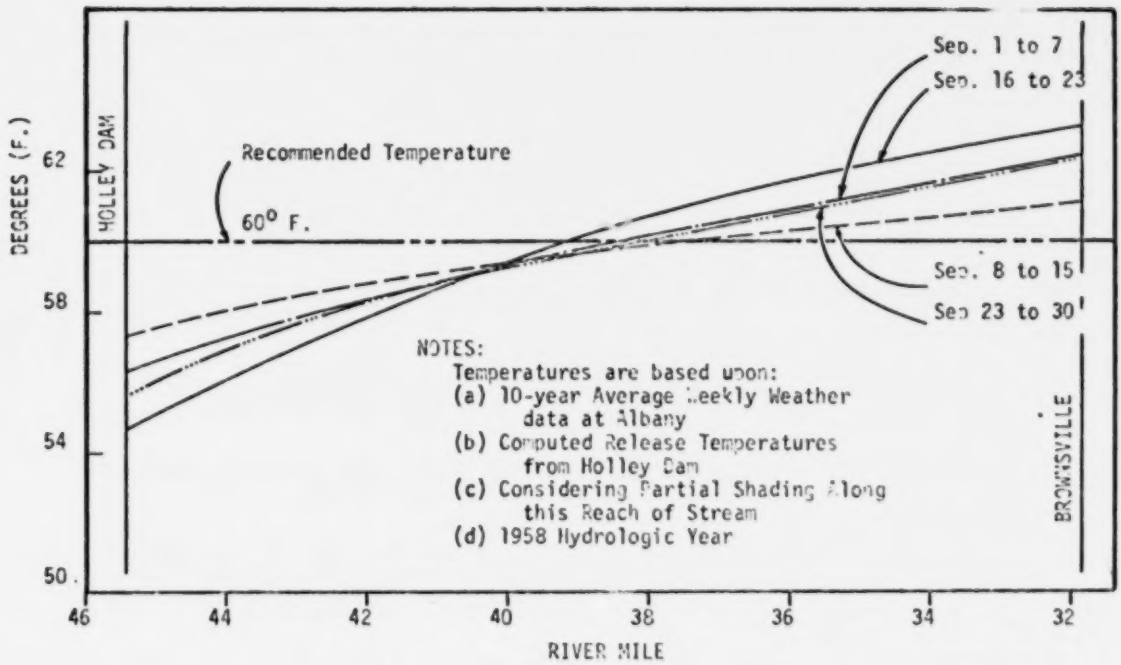

FIGURE 9. SEPTEMBER TEMPERATURE PROFILES - CALAPOOIA RIVER

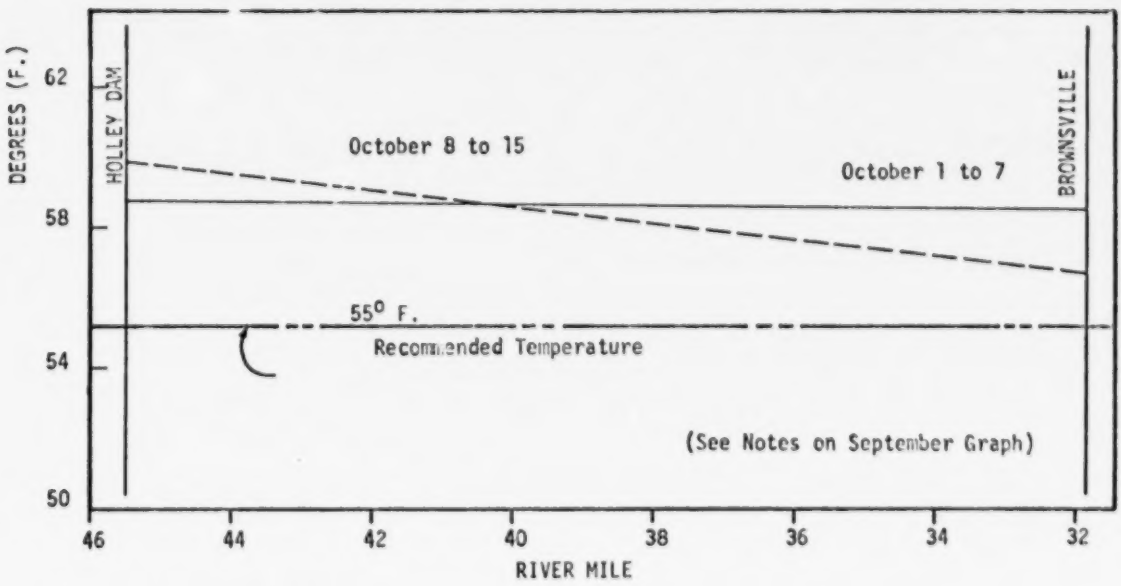

FIGURE 10. OCTOBER TEMPERATURE PROFILES - CALAPOOIA RIVER

BIBLIOGRAPHY

Upper Willamette Resource Conservation and Development Project Program. Preparation assisted by the U. S. Department of Agriculture, Soil Conservation Service, Portland, Oregon, December 1964.

Middle Willamette River Basin. State Water Resources Board, Salem, Oregon, June 1963.

Middle Willamette Basin, Water Rights Summary. State Water Resources Board, Salem, Oregon, March 1962.

Water Quality Data Inventory, Bulletin No. 1. State Water Resources Board, Salem, Oregon.

Program for the Use and Control of the Water Resources of the Middle Willamette River Basin. State Water Resources Board, Salem, Oregon, June 22, 1964.

Dimick, R. E. and Fred Merryfield. "The Fishes of the Willamette River System in Relation to Pollution," Bulletin No. 20. Engineering Experiment Station, State College, Corvallis, Oregon, 1945.

Piper, A. M.. "Ground-water Resources of the Willamette Valley, Oregon," Water Supply Paper #890. U. S. Geological Survey, 1942.

Report on Sedimentation, Willamette River Basin, Oregon. Portland District, U. S. Army Corps of Engineers, December 1948 - July 1951.

Monmouth-Dallas Project, Oregon. Bureau of Reclamation, Region I, Boise, Idaho, December 1962.

Prediction of Thermal Energy Distribution in Streams and Reservoirs. Prepared for the California Department of Fish and Game by Water Resources Engineers, Inc., Walnut Creek, California, August 30, 1968.

Yearsley, John R. "A Mathematical Model for Predicting Temperatures in Rivers and River-Run Reservoirs," Working Paper No. 65. Federal Water Pollution Control Administration, Northwest Region, Portland, Oregon, March 1969.